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Fossil Dinoflagellate Cysts from Lake Gnotuk, Victoria, Australia

By Rex Harland*

Abstract: Seven previously undescribed fossil dinoflagellate cysts are reported from Lake Gnotuk, a highly saline volcanic crater lake in Victoria, Australia. The cysts are discussed in the light of recent Quaternary dinoflagellate studies; and in particular with regard to the problems of classification. A possible future solution is introduced whereby all Quaternary fossil cysts are classified in a natural scheme whilst older material is classified morphologically, with natural affinities stated where known or reasonably assured.

INTRODUCTION

In recent years the study of fossil Quaternary dinoflagellate cysts has greatly expanded. At present these palynomorphs are being treated as morphological entities as in Harland (1968), Harland and Downie (1969), Harland and Sarjeant (1970) and Downie and Singh (1969); and as complete natural entities by Wall and Dale (1968a, b) and Evitt and Wall (1968). It is becoming clear that a comprehensive system of taxonomy and classification is necessary to reconcile these two different approaches. The present paper, in describing a Holocene (Flandrian) assemblage of fossil dinoflagellate cysts, attempts to highlight the problems involved and to offer a tentative future solution.

The assemblage was obtained from Lake Gnotuk, a small volcanic crater lake situated close to the town of Gnotuk in south-west Victoria, Australia. Gnotuk lies about 8 miles to the north-east of Cobrico. The geographical setting may be seen in Fig. 1. Lake Gnotuk and Cobrico Swamp, the latter described by Harland and Sarjeant (1970), are both developed on Tertiary basalt lava flows. The sediments studied are, however, of Holocene (Flandrian) age. The extent of contamination in the geological environment is therefore slight, and indeed no recognizable reworked material was seen. The sample described in this paper was taken from surface mud in Lake Gnotuk under a water depth of 60-65 ft. Dr. D. M. Churchill, who collected the sample, also noted the presence of large number of living dinoflagellates in the highly saline lake water. The chemistry of the water is as follows:

Table 1

pH	8·60
Salinity	53·50 g/l
Na^+	16·70 „
K^+	0·62 „
Mg^{++}	2·17 „
Ca^{++}	0·18 „
Cl^-	33·00 „
SO_4^-	0·00 „
HCO_3^- and CO_3^-	0·014 „

Data from Bayly and Williams 1966.

It is unfortunate that only one slide was available to the author for study. This has been designated L.G.V./001 and is housed in the Palynological Collection of the Department of Geology, University of Alberta, Edmonton, Canada. The available material does not facilitate the study of large populations of cysts but the palynomorphs present are of such interest that they are herein described. The systematic positions of these cysts is purposely left 'loose' for reasons explained later.

TAXONOMY AND CLASSIFICATION

Lately research workers have become increasingly concerned with the taxonomy and classification of dinoflagellate cysts. Sarjeant and Downie (1966) reviewed the state of the various classifications to date and erected a purely morphological scheme for fossil dinoflagellate cysts. Wall and Dale (1968a), studying the theca-cyst relationship in many modern dinoflagellate taxa, suggested several new procedures that workers should adopt to ensure a comprehensive classification for both modern and fossil dinoflagellates. These procedures are quoted below:

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1. Modern dinoflagellate taxa must be redefined to attribute greater taxonomic importance to the cyst phase and should be restricted to include only specifically defined cyst morphotypes. Polyphyletic modern genera or species should be subdivided at some level. Fossil and dissociated living cysts then could be assigned to these redefined taxa on the basis of features of cyst morphology as one minimum requirement.

2. Fossil and living dinoflagellates which are synonymous according to cyst or thecal morphology must adopt a single epithet.

3. Extinct dinoflagellates must be allocated to taxa on the basis of their archeopyle plate equivalence, reflected tabulation, and other characters whose taxonomic value can be affirmed by reference to the holomorph, that is, the living dinoflagellate. The relative height of ornamentation upon a cyst would be of minor importance in this scheme.

Norris and McAndrew (1970), describing a postglacial freshwater cyst assemblage, criticize the scheme of Wall and Dale (op. cit.) and conclude that separate classifications are needed for cysts and thecae. At the moment then we have a morphological classification for fossil cysts, a biological one for modern thecae and various suggestions to erect a new comprehensive classification for modern dinoflagellates to include fossil cysts. A split between workers is developing: those

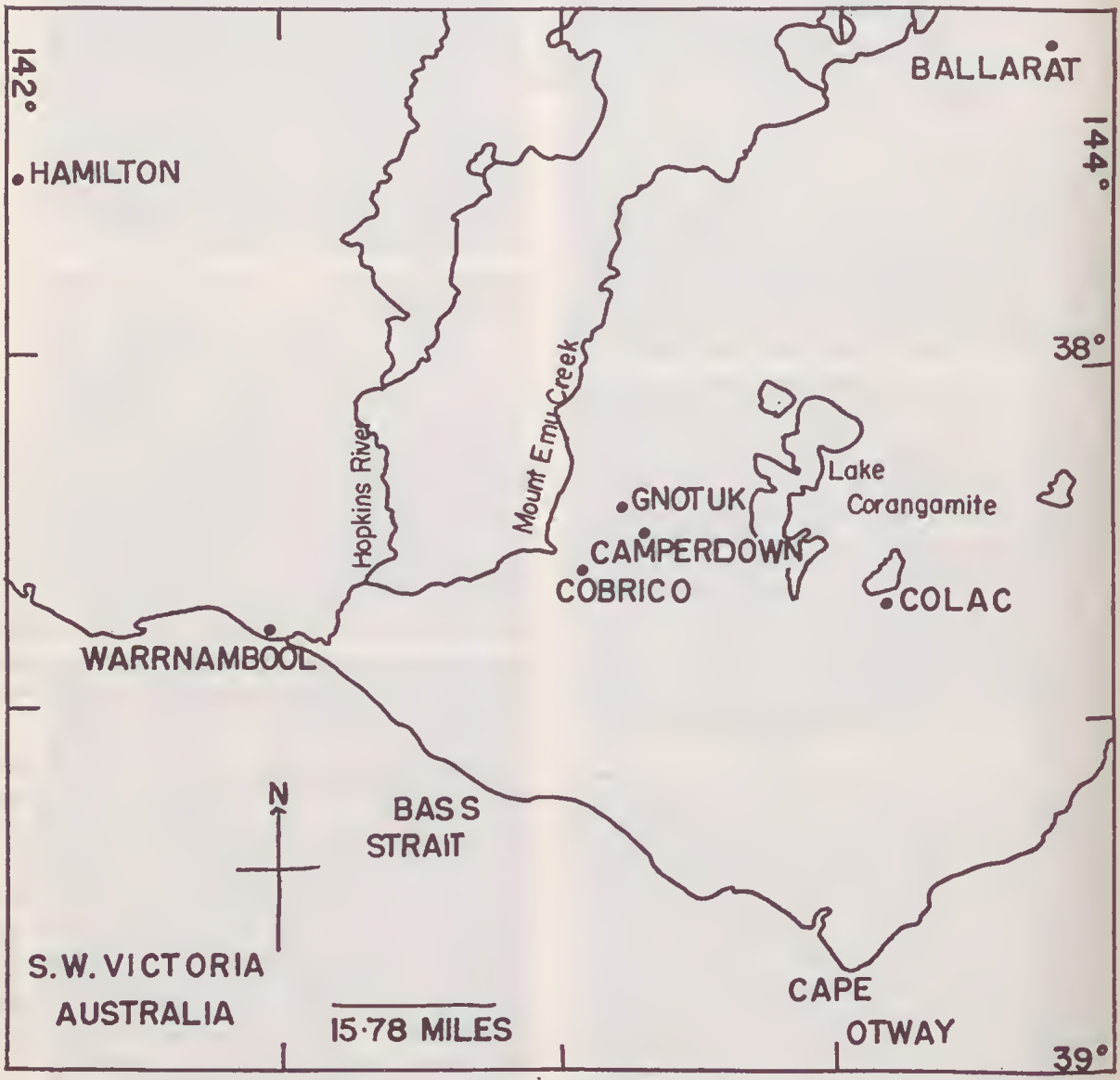


FIG. 1—Sketch Map of S.W. Victoria, Australia, showing the geographical location of Gnotuk.

who wish to see a separate classification for cysts and thecae and those who favour the new comprehensive approach. The present author would like to offer a 'compromise', at this stage, to prevent or alleviate the schism.

Norris (pers. comm.) has pointed out that morphological data need to be organized into conceptually meaningful units before taxonomy can be attempted. Similarly this must be done for any form of data to be used taxonomically. In dinoflagellate taxonomy there is still much argument at this fundamental level. Wall and Dale (1968a) contend that tabulation and archeopyle development are taxonomically stable characters and can be used without reserve in erecting a classification. Norris (pers. comm.) suggests that this is as yet unclear. Certainly in the case of the freshwater cysts studied by Norris and McAndrew, those of Harland and Sarjeant (1970), and those presently under consideration, the author would be inclined to support Norris's view. The relative importance of the degree of cyst condensation is another disputed taxonomic criterion. Sarjeant and Downie (1966) believe this to be of utmost importance in their classificatory scheme, whilst Wall and Dale (1968a) dismiss the criterion on the ground that 'spine length can be subject to considerable intraspecific variation'. It would seem then that there is some semantic confusion by what is meant by cyst condensation and what by spine length, and the difference between 'spine' and 'process'. The natural significance of all morphological attributes needs to be properly evaluated in order to select meaningful criteria for an ideal classification embracing both fossil and extant forms. The principles of numerical taxonomy (Rowell 1967) could well be a valuable addition to the 'classical' approach.

The author feels that at present a compromise is necessary. It is therefore suggested that all Quaternary fossil dinoflagellate cysts should be classified under a natural scheme, as it is reasonable to surmise that in the future the majority of Quaternary fossil cysts will be assigned to their parent thecae, in the same way that Quaternary pollen and spores are attributed to their parent plants. Physiological, cytological and genetical data must ultimately be included in such a taxonomy, and Norris and McAndrew (1970) suggest that a particularly fruitful line of research might be the detailed study of the process of cyst formation. The only realistic way to classify pre-Quaternary fossil material is on purely morphological grounds, taking into account the importance of the various morphological parameters. Ultimately an amalgamation of these two systems may be possible, especially if the cytological, physiological and genetical data are found to be relatively unimportant in the total taxonomic concept. It is the author's view that current knowledge is too meagre to allow the erection of a comprehensive classification at the present time.

The present assemblage does not fit into any of the schemes discussed, as none of its members can be assigned to parent thecae owing to the lack of knowledge of theca-cyst relationships in 'freshwater' dinoflagellates. In some cases it is considered reasonable to assign cysts to modern genera where the evidence allows, e.g. *Peridinium* and *Gonyaulax,* but in other instances the author had no alternative but to assign the cysts to a morphologically defined genus, e.g. *Aquadulcum.* Clearly this is not a very satisfactory situation; it points to the scope of future work necessary before a consistent taxonomic approach can be adopted.

SYSTEMATICS

Class Dinophyceae Pascher

Order Peridiniales Lindemann

Family Peridiniaceae Lindemann

Genus **Peridinium** Ehrenberg 1830

Type Species **P. cinctum** (O. F. Muller) Ehrenberg 1830; OD(M).

Peridinium sp. A

(Pl. 15, fig. 1-2; Fig. 2-5)

Description: Proximate cysts, spherican to ovoidal in shape. Compressed forms appear somewhat rectangular in outline. Two cyst walls are commonly closely adpressed except toward the apical region where the periphragm alone constructs a short apical horn. The resultant pericoel is usually very conspicuous. Cyst wall is 1-2 μ in thickness. Ornamentation is very variable, most commonly consisting of fine to coarse granules irregularly arranged on the cyst. These granules, constructed of periphragm, are often elongate producing a vermiculate appearance. One specimen had vermiculae parallel to the longitudinal axis of the cyst. Tabulation is typical for the genus, i.e. 4′, 7″, 6c, 6‴, 1p, 2⁗. The plate areas are defined by a single or a double raised suture, the latter possibly reflecting small growth areas on the mature theca. The apical series consists of four plates, plate 1′ being elongate and apparently an extension of the sulcal groove. The pre-cingular series consists of seven rectangular plates, plate 4″ being particularly conspicuous. The cingulum consists of six elongate-rectangular plates, and is 5-6 μ wide. The plates lie in a shallow groove and form a laevo-rotatory spiral. The sulcus is usually conspicuous and extends up to three-quarters of the length of the hypotract and only a short distance on to the epitract. The longitudinal sulcal and the posterior sulcal plates are usually well defined; in some specimens additional plates are evident. A tentative composite tabulation for these cysts is shown in Fig. 2-5. The post-cingular plate series

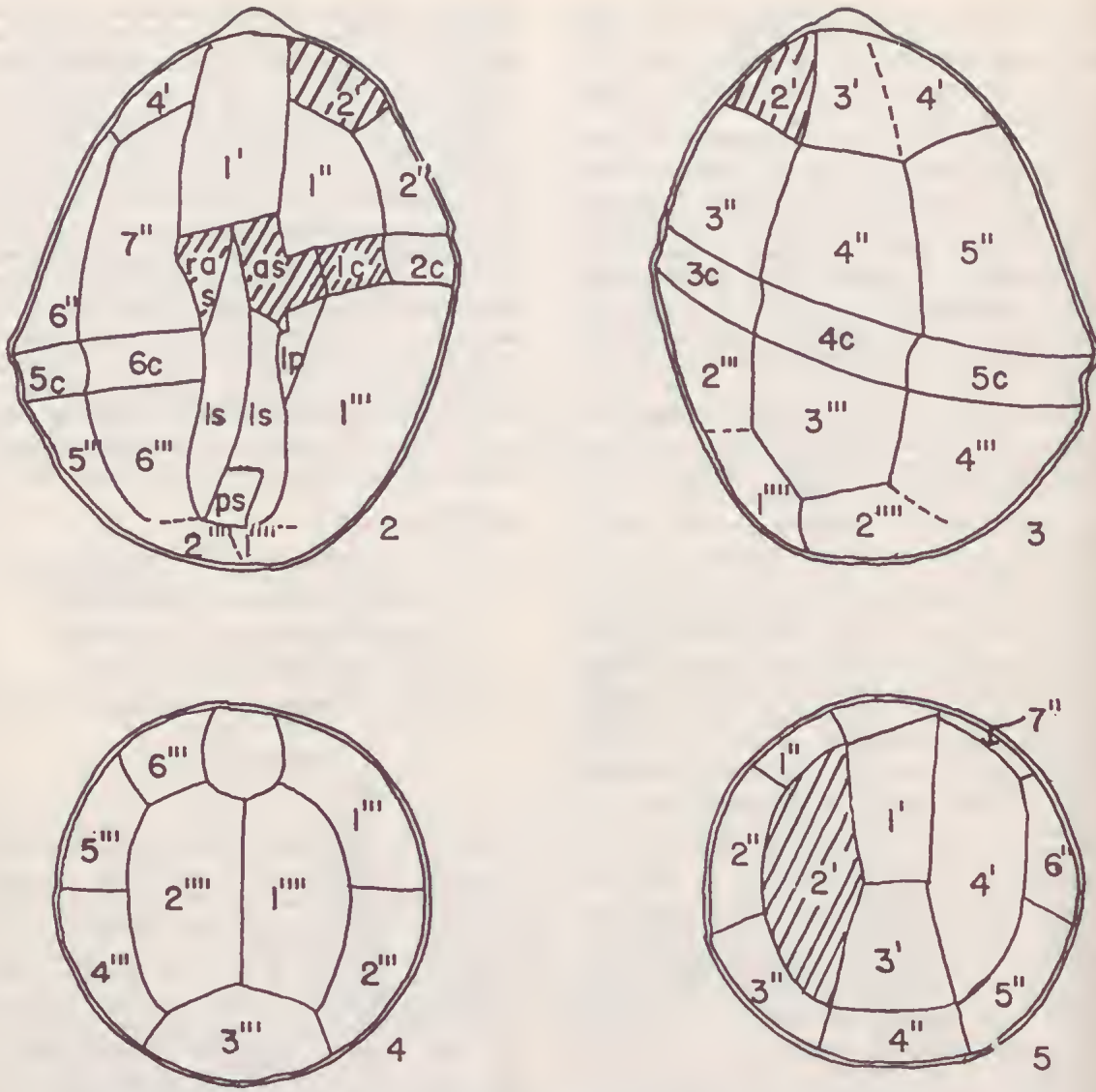


FIG. 2-5—*Peridinium* sp. A, Ventral view showing both types of possible archeopyle. *ls* longitudinal sulcal plate, *ps* posterior sulcal plate, *as* anterior sulcal plate, *ras* right accessory sulcal plate. × 1,500. (3) *Peridinium* sp. A, Dorsal view. × 1,500. (4) *Peridinium* sp. A, Antapical view. × 1,500. (5) *Peridinium* sp. A, Apical view. × 1,500.

consists of six plates of which pentagonal plate 3''' is the most conspicuous. A small triangular posterior intercalary plate is also evident in some specimens. This plate is so variable in size from specimen to specimen that it may in fact be part of the sulcal plates. The tabulation is completed by two large antapical plates. Two possible archeopyle developments occur: in one an archeopyle was formed by loss of a single apical plate, i.e. 2', that could be termed A in the terminology of Evitt (1967); and a second resulted from the loss of plate 1c and sulcal plates as indicated in Fig. 2. Evitt (op. cit.) and Norris and McAndrew (1970) all indicate the complexities of archeopyle formation in *Peridinium* so that it is no surprise that these specimens do not fit into the usual modes of archeopyle formation. It may be, however, that these ruptures are entirely accidental.

DIMENSIONS: Length 52 (54·2) 59 μ; breadth 46 (50·8) 54 μ. Five specimens were measured. The figure in parenthesis is the arithmetic mean of the data.

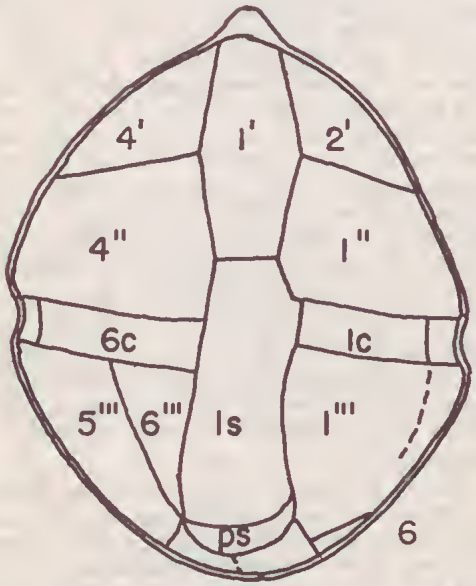
REMARKS: The cysts described above are assignable to the genus *Peridinium* by virtue of their tabulation, but do not compare closely to any of the fossil cysts described to date. The form differs from those de-

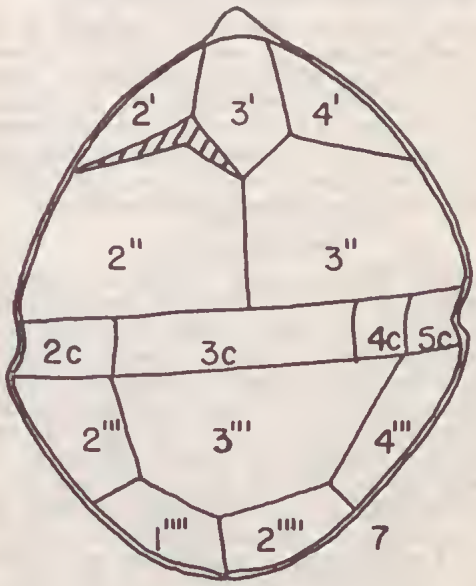
scribed by Evitt and Wall (1968) and Wall and Dale (1968a) in the lack of antapical horns. The two possible types of archeopyle point to the possibility that at least two species of *Peridinium* may be represented in this taxon. Certainly it makes no sense to erect a new genus distinct from *Peridinium* based on the differences of archeopyle structure. No definitive proof is available to the affinity of these cysts to a motile theca but a loose assignment to *Peridinium* appears justified.

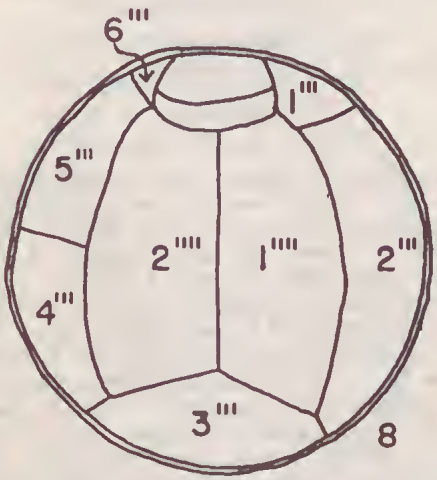
? Peridinium sp. B

(Pl. 15, fig. 3-4; Fig. 6-9)

DESCRIPTION: Proximate cyst, ovoidal to peridinoid in shape. Cyst made up of two walls closely adpressed except at the apex where the periphragm makes up an apical horn, resulting in an apical pericoel. The cyst wall is 1-2 μ thick. Ornamentation consists of granules, up to 0·5 μ in diameter, uniformly arranged on plate areas. Tabulation is 4′, ? 4″, 6c, 6‴, 2⁗. Plate areas are delimited by single and double raised sutures. The apical series consists of four plates of which 1′ is an elongate hexagonal plate and 3′ is pentagonal. The pre-cingular series appears to comprise only four large plates. The cingulum lies in a shallow groove and takes the form of a laevo-rotatory spiral. It consists of five elongate rectangular plates and one small square plate (4c). The cingulum is 3 μ







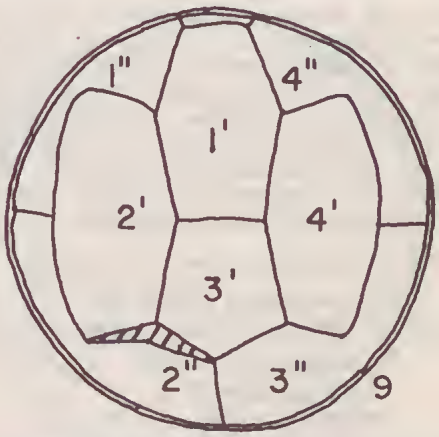


FIG. 6-9— ? *Peridinium* sp B, Ventral view. *ls* longitudinal sulcal plate, *ps* postcrior sulcal plate. × 1,500. (7) ? *Peridinium* sp. B, Dorsal view showing the archeopyle. × 1,500. (8) ? *Peridinum* sp. B, Antapical view. × 1,500. (9) ? *Peridinium* sp. B, Apical view. × 1,500.

in width and has a displacement equal to half the cingulum width. The sulcus is well developed, lying mainly on the hypotract and extending only one-fifth on to the epitract. It consists of a single large longitudinal sulcal plate and a small posterior sulcal plate. The post-cingular plate series comprises six plates, plate 3‴ large and pentagonal, plate 6‴ small and triangular. The antapical series consists of two large square plates. The archeopyle appears as a split between plates 2′ and 3′ and 2″ on the epitract; there appears to be no plate loss. This again may be accidental, however. A tentative composite tabulation is diagrammatically illustrated in Fig. 6-9.

Dimensions: Length (53 (54) 55 μ; breadth 48 (52) 56 μ. Two specimens were seen and measured.

Remarks: This fossil appears best assigned to the genus *Peridinium* although some doubt is expressed due to the presence of only four pre-cingular plates. It differs from *P.* sp. A in lacking two pre-cingular plates, in the lack of accessory plates in the ventral area, and finally in the possible mode of archeopyle formation. Unfortunately only two specimens of this interesting form were observed in the assemblage.

Peridinium sp. C

Description: Proximate cyst, ovoidal in shape, the epitract being more conical than the hypotract. The cyst consists of two walls closely adpressed except where the periphragm constructs a prominent apical horn. A large apical pericoel is also present. Ornamentation consists of two types, microgranules and small sutural spines that stand 2-3 μ above the cyst surface. The tabulation is obscure but clearly of *Peridinium*-type in that the large pentagonal 3‴ is conspicuous. Plate areas are delimited by single and double raised sutures. The cingulum lies in a shallow groove 7 μ wide, and has a displacement equal to half its width. The sulcus is similar to that of *P.* sp A, although the multiplicity of sulcal plates was not seen. No archeopyle was observed.

Dimensions: Length 59 μ; breadth 50 μ. One specimen seen and measured.

Remarks: This specimen is assigned to the genus *Peridinium* on the evidence of tabulation. However, considerable intraspecific variation in thecal and cyst morphology is known within such genera as *Peridinium*, *Gonyaulax*, and *Ceratium*. It is probable that the specimen is linked with *P.* sp. A via such variation, but this cannot be demonstrated from the available material. Unfortunately the single specimen observed could not be illustrated adequately.

Family Gonyaulacaceae Lindemann

Genus **Gonyaulax** Diesing 1866

Type Species **G. spinifera** (Claparède and Lachmann) Diesing 1866; OD(M).

Gonyaulax sp. A

(Pl. 15, fig. 5-9; Fig. 10-13)

Description: Proximate cysts, spherical to ovoidal, may appear rectangular if compressed. Two cyst walls are present, closely adpressed except where the periphragm makes up an apical horn with the development of a small apical pericoel. The cyst wall is 1-2 μ thick. Ornamentation takes the form of granules, often large and elongate in plan and arranged uniformly on the periphragm. A true vermiculate appearance was not, however, seen in any specimen here attributed to the genus. Tabulation is 4′, 6″, 6c, 6‴, 1⁗. The plate areas are defined by single or double raised sutures. The apical series consists of four plates of which 1′ is elongate and appears to form an extension to the sulcus, and plate 3′ which is short and trapezoidal. The pre-cingular plate series of six plates has as its most conspicuous plate a large hexagonal 4″. The cingulum lies in a groove and consists of six elongate-rectangular plates; it bisects the cyst and forms a laevo-rotatory spiral. Displacement is equal to one width of the cingulum (9 μ). The sulcus is conspicuous and commonly consists of a single sulcal plate with the possible addition of a posterior, left and left accessory sulcal plates. The sulcus extends a short distance on to the epitract and one-quarter of the way on to the hypotract. The post-cingular plate series consists of six rectangular plates; the single antapical plate is square. A tentative tabulation is illustrated in Fig. 10-13. One specimen showed a possible archeopyle development, by loss of plate 5″.

Dimensions: Length 52 (55·4) 59 μ; breadth 48 (52·6) 58 μ. Five specimens were seen and measured.

Remarks: All five specimens seen are assignable to the genus *Gonyaulax*, but are not comparable to any fossil cyst described to date. A study of the motile thecae of Lake Gnotuk is obviously essential.

Addendum

Due to the paucity of material the descriptions and text-figures of the *Peridinium* spp. and *Gonyaulax* sp. are intended as a general indication of the morphology of these cysts. Certain inconsistencies are apparent and it is hoped that with future research their morphology and taxonomic position will become clearer.

Incertae Familiae

Genus **Diplopeltopsis** Pavillard 1913

Type Species **D. minor** (Paulsen) Pavillard 1913; OD.

Diplopeltopsis sp. A

(Pl. 15, fig. 10-11; Fig. 14-15)

Description: Proximate cyst, spherical, with a small horn at the apical end. Cyst wall composed of two layers closely adpressed even at the apex. The ornamentation consists of small granules in a dense arrangement giving the cyst a scabrate appearance. The tabulation is indistinct and where seen the plate areas are delineated by narrow faint raised ridges; of the tabulation figured by Wall and Dale (1968a) plates 2a, 3″, 4″, 5″, and 6″ could be faintly seen on this specimen. The cingulum, 4 μ wide, is conspicuous on the dorsal region of the cyst lying in a shallow groove. On the ventral surface the exact position of the cingulum is unclear. A faint sulcal area, lying entirely on the hypotract, may also be seen. The archeopyle is conspicuous but due to the lack of cingular detail on the ventral surface its exact position

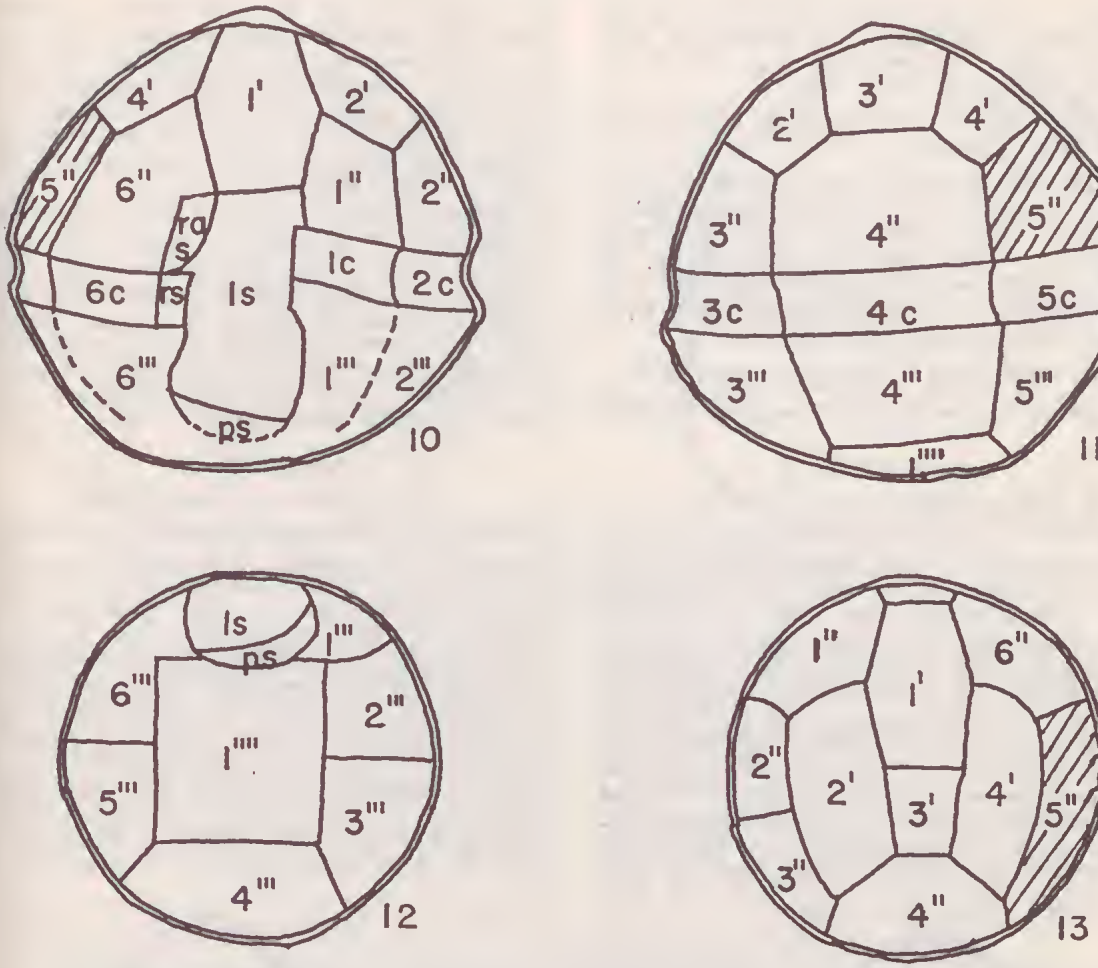


FIG. 10-13—*Gonyaulax* sp. A, Ventral view showing the archeopyle. *ls* longitudinal sulcal plate, *ps* posterior sulcal plate, *ras* right accessory sulcal plate, *rs* right sulcal plate. × 1,000. (11) *Gonyaulax* sp. A, Dorsal view showing the archeopyle. × 1,000. (12) *Gonyaulax* sp. A, Antapical view. × 1,000. (13) *Gonyaulax* sp. A, Apical view. × 1,000.

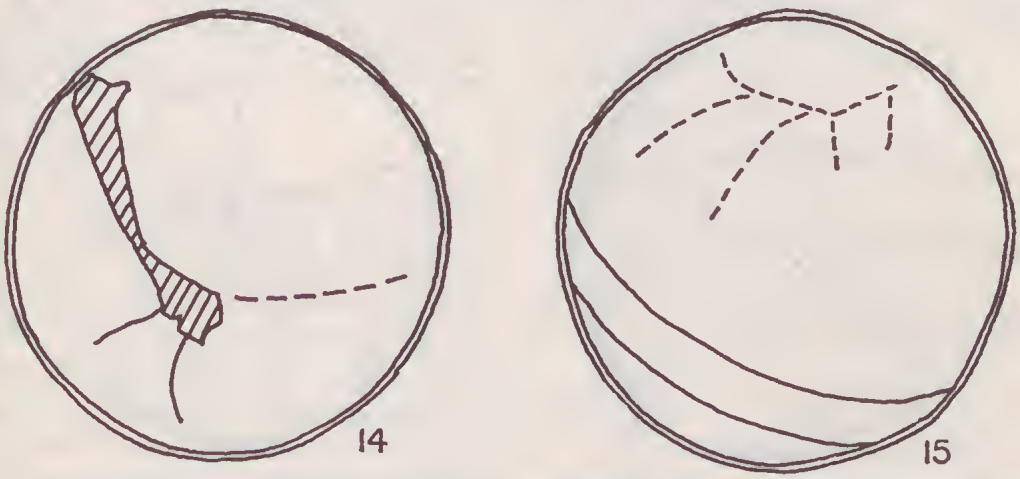


FIG. 14-15—*Diplopeltopsis* sp. A, Ventral view showing the archeopyle. × 1,500. (15) *Diplopeltopsis* sp A, Dorsal view. × 1,500.

is difficult to determine. It is thought, however, to be a split between the cingular and pre-cingular plate areas but without the loss of any plates. This occurs in the area of plates 6″ and 7″.

Dimensions: Length 45 μ; breadth 45 μ. One specimen seen and measured.

Remarks: This specimen compares favourably with *Diplopeltopsis minor* (Paulsen) Pavillard as figured by Wall and Dale (1968a). An obvious difference, however, is the lack of a clear tabulation on the specimen under discussion. As Wall and Dale (op. cit.) have stated these cysts are scarcely known from the fossil record.

Genus **Aquadulcum** Harland and Sarjeant 1970

Type Species **A. serpens** Harland and Sarjeant 1970; OD.

? Aquadulcum sp. A

(Pl. 15, fig. 12, Plate 16, fig. 1, 8; Fig. 16-17)

Description: Proximate cyst, subspherical in shape. Cyst composed of two walls, closely adpressed except at the apex where a slight apical horn is developed with a correspondingly small apical pericoel. The epitract is markedly more conical than the hypotract and these two areas are ornamented with granules and vermiculae. The vermiculae are clearly elongate parallel to the longitudinal axis of the cyst. There are also thicker regions in the cyst wall, apparently where only the endophragm has thickened. No corresponding structure is seen on the periphragm, and no tabulation or pattern could be discerned in their arrangement. The cingulum is a broad groove, 7-8 μ wide, and is delimited by a double raised suture. It is the usual laevo-rotatory helicoid. There are possibly six cingular plates. The sulcus is a large structure, lying in a groove and consisting of two plates, an anterior sulcal plate and a posterior sulcal plate. It extends for a short distance on to the epitract but is conspicuously present on the hypotract. A possible triangular pre-cingular plate is seen in 1‴ position. Archeopyle develops by the loss of plate 1″.

Dimensions: Length 52 (53·5) 55 μ; breadth 45 (47·5) 50 μ. Two specimens were seen and measured.

Remarks: This cyst may reasonably be attributed to *Aquadulcum* although three of its features, granular ornament on cingulum and sulcus, an apical pericoel and a pre-cingular archeopyle, do not accord with the genus. It may prove necessary, with availability of further material, to extend the diagnosis of *Aquadulcum* so as to include this cyst.

? Aquadulcum sp. B

(Pl. 16, fig. 2-7, 9-11; Fig. 18-19)

Description: Proximate cyst, spherical to ovoidal in shape, cyst wall consists of two closely adpressed layers except at the apex where an apical horn, spine and apical pericoel are developed. This varies with specimen; in some it is very conspicuous whereas in others it is only a small development. In one specimen the apical horn was surmounted by a delicate spine, as illustrated in Pl. 16, fig. 11. Ornamentation varies from microgranulate through coarsely granulate to vermiculate. The cingulum lies in a shallow groove which is delimited by a single or double raised suture; it is 4-5 μ wide and forms a laevo-rotatory helicoid. It has an ornament similar to the rest of the cyst. The sulcus is conspicuous and is confined to the

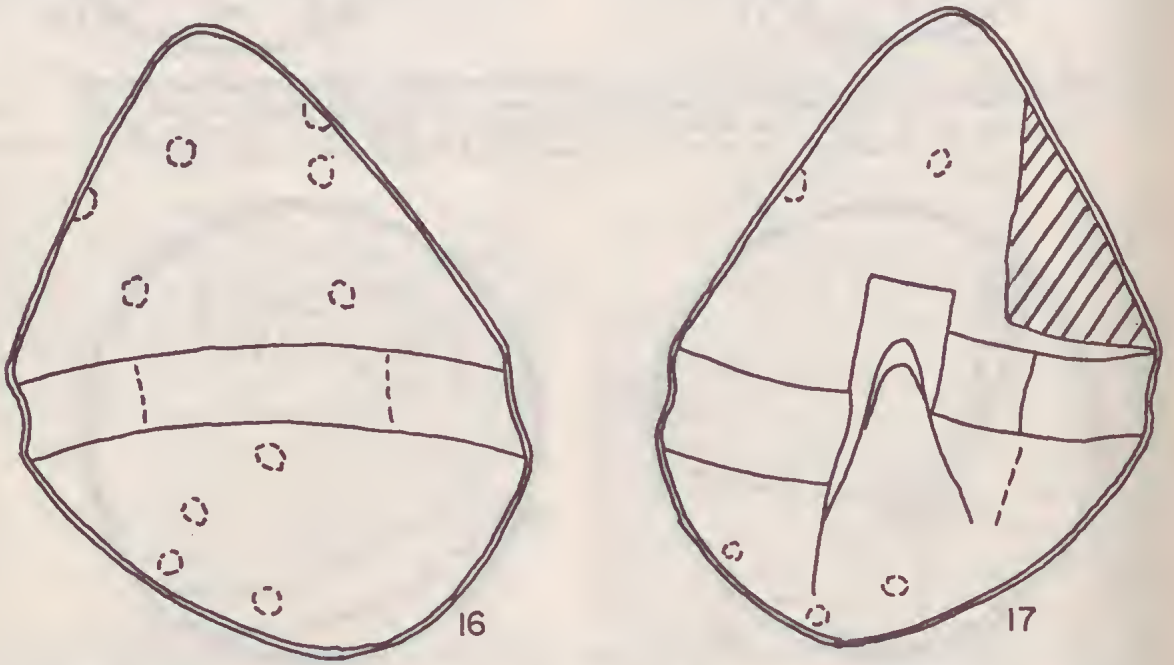


Fig. 16-17—? *Aquadulcum* sp. A, Dorsal view. × 1,500. (17) ? *Aquadulcum* sp. A, Ventral view showing the archeopyle. × 1,500.

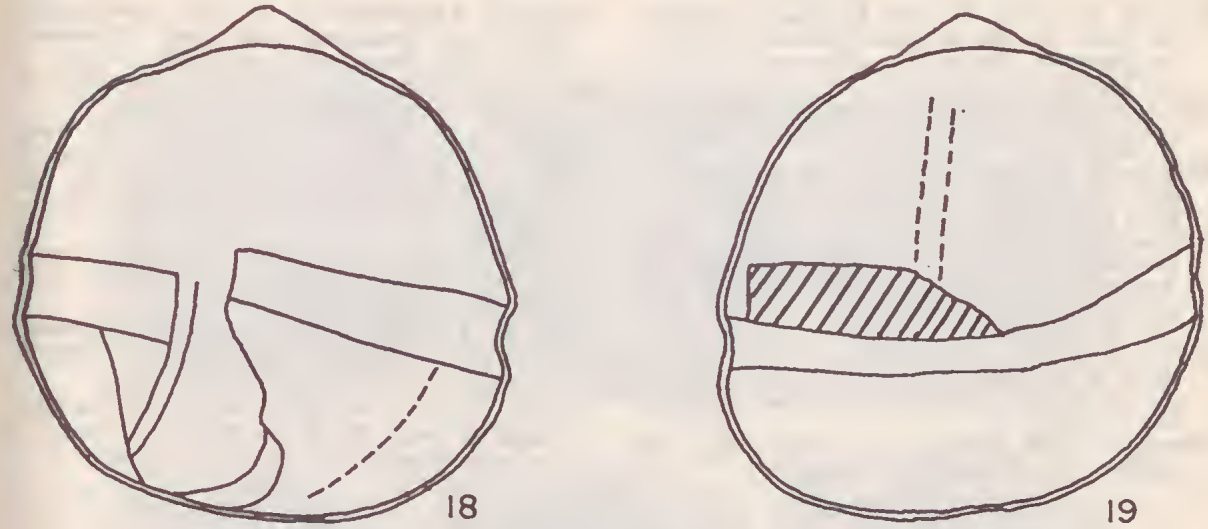


FIG. 18-19—? *Aquadulcum* sp. B, Ventral view. × 1,200. (19) ? *Aquadulcum* sp. B, Dorsal view showing the archeopyle. × 1,200.

hypotract. It is made up of a longitudinal suleal plate, a posterior suleal plate and a right suleal plate. One or two plate areas, defined by ornament differenees, oceur on the eyst. Two plates in the pre-eingular plate series are delimited by a groove extending from the 'areheopyle'; and two others, possibly 1‴ and 6‴, are defined by a raised suture. The areheopyle, illustrated in Pl. 16. fig. 10, appears to develop by partial loss of one of the pre-eingular plate series, possibly plates 2″ or 3″.

DIMENSIONS: Length 51 (53·3) 57 μ; breadth 46 (46·6) 50 μ. Six speeimens measured, the total available material.

REMARKS: These speeimens, like those of the preeeding eategory, are probably assignable to the genus *Aquadulcum* but eertain differenees are apparent in the ornamentation and overall cyst morphology. The present eysts differ from those of ? *A.* sp. A in not having the elements of ornament aligned parallel to the longitudinal axis of the eyst, in archeopyle structure, and in laeking eonieal epitract and endophragmal thickenings.

CONCLUSIONS

A new assemblage of seven previously unknown fossil dinoflagellate cysts has been deseribed from Lake Gnotuk, Victoria, Australia. Taxonomieally these proved to be a little diffieult to handle because of the laek of previous researeh. In a diseussion of the taxonomie problems assoeiated with dinoflagellate cysts, therefore, the author suggests that an arbitrary boundary be ereeted between Quaternary forms and all older material as is generally praetised with pollen and spores. Quaternary dinoflagellates would aeeordingly be classified in a natural scheme where possible, whilst all older material would be morphologieally classified but with a elear knowledge of character priorities. The present assemblage is dealt with under this philosophy.

The water chemistry of Lake Gnotuk is also tabulated (Table 1) beeause it seems highly probable that dinoflagellate assemblages are partieularly sensitive to this environmental parameter as a comparison between the assemblages of Harland and Sarjeant (1970), Norris and McAndrew (1970) and the present assemblage suggests.

ACKNOWLEDGMENTS

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EXPLANATION OF PLATES 15 AND 16

All photographs are at a magnification of × 750 except where otherwise stated.

PLATE 15

FIG. 1—*Peridinium* sp. A, Dorsal view.
FIG. 2—*Peridinium* sp. A, Ventral view.
FIG. 3—? *Peridinium* sp. B, Dorsal view.
FIG. 4—? *Peridinium* sp. B, Ventral view.
FIG. 5—*Gonyaulax* sp. A, Dorsal view.
FIG. 6—*Gonyaulax* sp. A, Ventral view.
FIG. 7—*Gonyaulax* sp. A, Dorsal view.
FIG. 8—*Gonyaulax* sp. A, Ventral view slightly oblique.
FIG. 9—*Gonyaulax* sp. A, Median view slightly oblique.
FIG. 10—*Diplopeltopsis* sp. A, Ventral view showing the archeopyle.
FIG. 11—*Diplopeltopsis* sp. A, Dorsal view.
FIG. 12—? *Aquadulcum* sp. A, Dorsal view.

PLATE 16

FIG. 1—? *Aquadulcum* sp. A, Ventral view showing the archeopyle.
FIG. 2—? *Aquadulcum* sp. B, Ventral view.
FIG. 3—? *Aquadulcum* sp. B, Dorsal view showing the archeopyle.
FIG. 4—? *Aquadulcum* sp. B, Median view.
FIG. 5—? *Aquadulcum* sp. B, Ventral view.
FIG. 6—? *Aquadulcum* sp. B, Median view.
FIG. 7—? *Aquadulcum* sp. B, Dorsal view.
FIG. 8—? *Aquadulcum* sp. A, Detail of archeopyle. × 2,000.
FIG. 9—? *Aquadulcum* sp. B, Detail of apex to show the structure. × 2,000.
FIG. 10—? *Aquadulcum* sp. B, Detail of archeopyle. × 2,000.
FIG. 11—? *Aquadulcum* sp. B, Detail of apex to show the delicate spine. × 2,000.